12-20-99

A

Patent Application
Docket No. 27757-00414
P98-2379

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of: Raymond, et al.

For: METHOD AND APPARATUS FOR DETECTING THE PRESENCE OF A HOT-PLUGGABLE COMPONENT IN A COMPUTER SYSTEM

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

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Type or Print Name Christy Wilson

Christy Wilson
Signature

Sir:

PATENT APPLICATION TRANSMITTAL LETTER

Transmitted herewith for filing, please find the following:

X Specification, claims and abstract of the above-referenced patent application (total of 23 pages)

X 2 sheet(s) of drawing(s) (__formal/ X informal).

X Combined Declaration and Power of Attorney by Inventors (Signed).

X An Assignment of the invention to: Compaq Computer Corporation

__ A verified statement claiming small entity status under 37 CFR 1.9 and 1.27.

X Other (specify): Acknowledgment postcard .

__ This application is a:

__ Continuation
__ Divisional
__ Continuation-In-Part

of prior copending parent application Serial No. __filed on ___now pending.

The filing fee has been calculated as shown below:

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__ Any filing fees under 37 CFR 1.16 including fees for presentation of extra claims.

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Type or Print Name Christy Wilson

Christy Wilson
Signature

METHOD AND APPARATUS FOR DETECTING THE PRESENCE OF A HOT-PLUGGABLE COMPONENT IN A COMPUTER SYSTEM

FIELD OF THE INVENTION

The present invention pertains in general to techniques for detecting the presence of hot-pluggable components in a computer system, and in particular, but not by way of limitation, to a method and apparatus incorporating an electromagnetic energy source and an electromagnetic energy detector for determining when a hot-pluggable component's presence inhibits transmission of electromagnetic energy generated by the electromagnetic energy source.

BACKGROUND OF THE INVENTION

Early computer designs generally included a chassis with a plurality of individual components and assemblies mounted therein and connected to one another by means of wires, cables, brackets, nuts, bolts and the like. A major computer design advance occurred with the advent of printed circuit boards, integrated circuits and modular component assemblies. The printed circuit boards were, for example, formed of lightweight material and housed a myriad of components which were electrically interconnected with the component assemblies through wiring harnesses. The wiring harnesses and hard wire connections were subsequently replaced by technologically advanced connectors used for integrally coupling the individual components to each other and to other circuitry in the computer.

In the design of electronic equipment, the use of connectors, modular components, and specialized hardware has permitted key components and printed circuit boards to be efficiently added and removed. Such ease in the addition and deletion of computer components and printed circuit boards has facilitated assembly repair, upgrade, and/or changes in functionality.

Computer reliability and serviceability are also valuable design aspects. Originally, a rule of practice in the maintenance of electrical circuitry, such as

computer hardware, was that of always turning the power to the computer off before components or printed circuit boards were added or removed from the computer chassis or support frame. Recent innovations have addressed the desirability to insert and remove modular components and printed cards from electrical equipment, such as computer hardware, when the computer is electrically connected and operational, i.e. "hot." This is now possible for hot-pluggable hard drives, and in these cases, the power may be disconnected from only the connector of the drive to be inserted and removed while allowing the adjacent components to remain "hot."

Removable computer components today include disc drives, drive cages, fans, power supplies, system I/O modules, processor boards, and other subassemblies. As referenced above, the removability of computer components allows for better overall serviceability of the computer system, which is a distinct advantage to both the user and the maintenance technician. A defective power supply in the main or central computer generally requires prompt replacement in order to limit downtime. It is for this reason that modular components and connectors facilitate prompt replacement and are thus popular in many computer designs.

The modularity of computer systems is thus recognized as an important design consideration. As referenced above, modules can be removed and examined for operability or other purposes much easier than permanently mounted fixtures within a computer chassis. Because computers provide an integral part of most business operations, it is of utmost importance to maintain the reliability and integrity of the computer system. When the various elements of a computer can be easily removed in a modular form, they can also be replaced to maintain the operational status of the computer.

Despite the advantages of allowing electrical components of a computer system to be hot-pluggable there are certain concerns and potential problems associated with hot-pluggable computer systems. In order to prevent damage to the hot-pluggable component and the computer system and to prevent electrical shock to a user inserting or removing the hot-pluggable component, computer systems include a mechanical switch associated with each hot-pluggable component connector which must be physically switched off and on during removal and insertion of the hot-pluggable component. The mechanical switch adds cost to the computer system, requires additional space for locating the switch, and can reduce reliability of the overall computer system due to the mechanical nature of the switches.

It would be advantageous, therefore, to devise a method and apparatus for detecting the presence of hot-pluggable components in a computer system without the use of mechanical switches.

SUMMARY OF THE INVENTION

The present invention comprises a method and apparatus for detecting the presence of hot-pluggable components in a computer system. The method and apparatus includes an electromagnetic energy source located on a first side of a system board proximate an edge connector, the electromagnetic energy source for generating electromagnetic energy directed at least toward a second opposing side of the system board. The method and apparatus further includes an electromagnetic energy detector located on the second side of the system board, the electromagnetic energy detector for detecting a presence of electromagnetic energy when a hot-pluggable component is not mated to the edge connector and the electromagnetic energy is thereby unobstructed by the hot-pluggable component, the electromagnetic energy detector further for detecting an absence of electromagnetic energy when the hot-pluggable component is mated to the edge connector and the electromagnetic energy is thereby obstructed by the hot-pluggable component.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention may be had by reference to the following Detailed Description and appended claims, when taken in conjunction with the accompanying Drawings wherein:

Figure 1 is a frontal perspective of the present invention for detecting the presence of a hot-pluggable component in a computer system including functional blocks for effectuating the present invention;

Figure 2 is a cross sectional perspective of a first embodiment of the present invention for detecting the presence of a hot-pluggable component in a computer system; and

Figure 3 is a cross sectional perspective of a second embodiment of the present invention for detecting the presence of a hot-pluggable component in a computer system.

DETAILED DESCRIPTION

Referring now to Figure 1, there is respectively illustrated a frontal perspective of the present invention for detecting the presence of a hot-pluggable component in a computer system including functional blocks for effectuating the present invention. A computer system is shown generally at 100 and includes a

system board 110 and a hot-pluggable component 120. The hot-pluggable component 120 is connected to the system board 110 by mating an edge connector 130 of the hot-pluggable component 120 to a corresponding edge connector 140 of the system board 110. The hot-pluggable component 120 can be any type of computing device such as, but not limited to, a disk controller, a network interface card or a video card and is designed such that the hot-pluggable component 120 can be connected to the system board 110 of the computer system 100 while the computer system 100 is powered-up and operating. A further, more detailed description of two embodiments of the present invention is now provided in Figures 2 and 3.

Referring additionally now to Figure 2, there is illustrated a cross sectional perspective of a first embodiment of the present invention for detecting the presence of the hot-pluggable component 120 in the computer system 100. Prior to connection of the hot-pluggable component 120 to the system board 110, a processor 150 determines that the hot-pluggable component 120 is not connected to the system board 110 and instructs a power supply 160 to disable power to the edge connector 140 of the system board 110. It should be noted that the edge connector 140 can be replaced with other connectors, including cable connectors, fibre channel connectors, USB connectors, serial connectors, etc. To detect the

absence of the hot-pluggable component 120, an electromagnetic energy source 170, for instance an infra-red transmitter, magnetic radiation source, ultrasonic transmitter or other energy transmitter, is located on a first side 180 of the system board 110 proximate a first end of the edge connector 140 of the system board 110 and transmits electromagnetic energy 190 directed at least toward an electromagnetic energy detector 200 located on a second side 210 of the system board 110 proximate the first end of the edge connector 140 of the system board 110. The source 170 and the detector 200 can be constructed of individual units or, as is commonly available in the industry, can be constructed in a single unit. In either event, the source 170 and detector 200 combination is identified as element 220 in Figure 1, for purposes of clarity.

When the hot-pluggable component 120 is absent, and therefore not connected to the system board 110, the electromagnetic energy 190 transmitted by the source 170 travels unimpeded and is detected by the detector 200. The detection of a presence of the electromagnetic energy 190 is communicated to the processor 150 which interprets the presence of the electromagnetic energy 190 as an indication that the hot-pluggable component 120 is not present. The processor 150 (or "hot plug" controller) stores the indication that the hot-pluggable

component 120 is not present and instructs the power supply 160 to disable power to the edge connector 140 on the system board 110.

When the hot-pluggable component 120 is present and connected to the system board 110 the electromagnetic energy 190 transmitted by the source 170 is impeded by the hot-pluggable component 120 and the electromagnetic energy 190 is not detected by the detector 200. The detection of an absence of the electromagnetic energy 190 is communicated to the processor 150 which interprets the absence of the electromagnetic energy 190 as an indication that the hot-pluggable component 120 is present. The processor 150 stores in the hard drive 230 the indication that the hot-pluggable component 120 is present and instructs the power supply 160 to enable power to the edge connector 140 on the system board 110.

The location of the source 170 and detector 200 combination 220 and the shape of the hot-pluggable component 120 are designed such the edge connector 130 of the hot-pluggable component 120 makes physical and electrical contact with the edge connector 140 of the system board 110 prior to the hot-pluggable component 120 obstructing the electromagnetic energy 190 as the hot-pluggable component 120 is mated to the system board 110. Similarly, as the hot-pluggable component 120 is extracted from the system board 110, the hot-pluggable

component 120 clears the path of the electromagnetic energy 190 prior to the edge connector 130 of the hot-pluggable component 120 breaking physical and electrical contact with the edge connector 140 of the system board 110. Therefore, the edge connector 140 of the system board 110 is always powered-down when electrical contact is made or broken between the edge connector 130 of the hot-pluggable component 120 and the edge connector 140 of the system board 110.

Referring additionally now to Figure 3, there is illustrated a cross sectional perspective of a second embodiment of the present invention for detecting the presence of the hot-pluggable component 120 in the computer system 100. The second embodiment of the present invention is identical to the first embodiment but further includes additional source 170 and detector 200 combinations 220 stacked on top of one another. Thus, whereas the first embodiment contains a first source 170A and a first detector 200A, the second embodiment further includes at least a second source 170B and detector 200B. It is understood, however, that the second embodiment of the present invention may include any number of additional source 170 and detector 200 combinations 220. Each of the source 170 and detector 200 combinations communicate with the processor 150 and can individually or collectively determine the presence or absence of the hot-pluggable component 120 within its affect region. Therefore, a determination can be made

by the processor 150 as to whether the hot-pluggable component 120 is approaching or retreating from the system board 110 by tracking the sequence of detections.

In a further implementation of both the first and second embodiments of the present invention an additional source 170 and detector 200 combination 220 in the case of the first embodiment, or an additional set of source 170 and detector combinations 220, in the case of the second embodiment, are located on a second side of the edge connector 140 of the system board 110. While the first and second embodiments accurately detect the presence or absence of the hot-pluggable component 120 if the hot-pluggable component 120 is inserted or removed sufficiently horizontal to the system board 110 it often occurs that the hot-pluggable component 120 is inserted or removed at an angle with respect to the system board 110. This is particularly common in the case where the hot-pluggable component 120 is removed as users tend to "rock" the hot-pluggable component 120 to remove the edge connector 140 from the system board 110. If the hot-pluggable component 120 is inserted or removed at an angle, the processor 150 may incorrectly determine the presence of absence of the hot-pluggable component 120. Use of the additional source 170 and detector 200 combination 220 or the additional set(s) of source 170 and detector 200

combination(s) 200 assures an accurate determination of the presence or absence of the hot-pluggable component 120.

Depending on the frequency of the electromagnetic energy 190 transmitted by the source 170, the material used to construct the hot-pluggable component 120 may, in certain circumstances, not impede the transmission of the particular electromagnetic energy 190. In such cases, additional material 300, which is impervious to the electromagnetic energy 190, is applied to the hot-pluggable component 120. For example, a plastic material or solder can be used as the additional material 300.

Yet in another embodiment of the present invention, an emitter/detector pair (i.e., the electromagnetic energy source and the detector) uses reflective energy to determine the presence of a hot-pluggable component. That is, when the hot pluggable component is in place, it reflects emitted infra-red energy (or any other type of energy) and the detector receives that reflected energy. Thus, the emitter and detector in this embodiment could be on the same side of the system board. When the hot-pluggable component is removed, nothing reflects the emitted energy and, accordingly, the detector indicates an absence of a hot-pluggable component.

Although the preferred embodiments of the apparatus and method of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it is understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

WHAT IS CLAIMED IS:

1. A computer system comprising:

an electromagnetic energy source located on a first side of a system board proximate an connector, the electromagnetic energy source for generating electromagnetic energy directed at least toward a second opposing side of the system board; and

an electromagnetic energy detector located on the second side of the system board, the electromagnetic energy detector for detecting a presence of electromagnetic energy when a hot-pluggable component is not mated to the connector and the electromagnetic energy is thereby unobstructed by the hot-pluggable component, the electromagnetic energy detector further for detecting an absence of electromagnetic energy when the hot-pluggable component is mated to the connector and the electromagnetic energy is thereby obstructed by the hot-pluggable component.

2. The computer system, as recited in claim 1, further comprising a processor for communicating with the electromagnetic energy detector for receiving the detection of the presence or absence of electromagnetic energy by the electromagnetic energy detector.

3. The computer system, as recited in claim 2, further comprising a hard drive for storing an indication that the hot-pluggable component is absent when the presence of electromagnetic energy is detected, the hard drive further for storing an indication that the hot-pluggable component is absent when the absence of electromagnetic energy is detected.

4. The computer system, as recited in claim 3, wherein the electromagnetic energy is infra-red energy, magnetic energy or ultrasonic energy.

5. The computer system of claim 1, wherein the connector is one of an edge connector, a cable connector, a fibre channel connector, and a USB connector.

6. A computer system comprising:

a means for generating electromagnetic energy located on a first side of a system board proximate a connector, the electromagnetic energy directed at least toward a second opposing side of the system board; and

a means for detecting electromagnetic energy located on the second side of the system board, the means for detecting electromagnetic energy detecting a presence of electromagnetic energy when a hot-pluggable component is not mated to the connector and the electromagnetic energy is thereby unobstructed by the hot-pluggable component, the means for detecting electromagnetic energy detector further detecting an absence of electromagnetic energy when the hot-pluggable component is mated to the connector and the electromagnetic energy is thereby obstructed by the hot-pluggable component.

7. The computer system, as recited in claim 6, further comprising a processing means for communicating with the means for detecting electromagnetic energy, the processing means for receiving the detection of the presence or absence of electromagnetic energy by the means for detecting electromagnetic energy.

8. The computer system, as recited in claim 7, further comprising a means for storing an indication that the hot-pluggable component is absent when the presence of electromagnetic energy is detected and further for storing an indication that the hot-pluggable component is absent when the absence of electromagnetic energy is detected.

9. The computer system of claim 6, wherein the connector is an edge connector.

10. A computer system comprising:

a first electromagnetic energy source located on a first side of a system board proximate a first end of a connector, the first electromagnetic energy source for generating electromagnetic energy directed at least toward a second side of the system board opposing the first electromagnetic energy source;

a second electromagnetic energy source located on the first side of the system board proximate a second end of the connector, the second electromagnetic energy source for generating electromagnetic energy directed at least toward the second side of the system board opposing the second electromagnetic energy source;

a first electromagnetic energy detector located on the second side of the system board, the first electromagnetic energy detector for detecting a presence of electromagnetic energy from the first electromagnetic energy source when a hot-pluggable component is not mated to the connector and the electromagnetic energy from the first electromagnetic energy source is thereby unobstructed by the hot-pluggable component, the first electromagnetic energy detector further for detecting an absence of the electromagnetic energy from the first electromagnetic energy source when the hot-pluggable component is mated

to the connector and the electromagnetic energy from the first electromagnetic energy source is thereby obstructed by the hot-pluggable component.

a second electromagnetic energy detector located on the second side of the system board, the second electromagnetic energy detector for detecting a presence of electromagnetic energy from the second electromagnetic energy source when the hot-pluggable component is not mated to the connector and the electromagnetic energy from the second electromagnetic energy source is thereby unobstructed by the hot-pluggable component, the second electromagnetic energy detector further for detecting an absence of the electromagnetic energy from the second electromagnetic energy source when the hot-pluggable component is mated to the edge connector and the electromagnetic energy from the second electromagnetic energy source is thereby obstructed by the hot-pluggable component.

11. The computer system of claim 10, wherein the connector is an edge connector.

12. A method for detecting the presence of a hot-pluggable component in a computer system comprising the steps of:

generating electromagnetic energy on a first side of a system board proximate a connector, the electromagnetic energy directed at least toward a second opposing side of the system board;

detecting a presence of the electromagnetic energy on the second side of the system board when the hot-pluggable component is not mated to the connector and the electromagnetic energy is thereby unobstructed by the hot-pluggable component; and

detecting an absence of electromagnetic energy on the second side of the system board when the hot-pluggable component is mated to the connector and the electromagnetic energy is thereby obstructed by the hot-pluggable component.

13. The method, as recited in claim 12, further comprising the step of communicating the detected presence or absence of electromagnetic energy to a processor.

14. The method, as recited in claim 13, further comprising the steps of:

storing an indication that the hot-pluggable component is absent when the presence of electromagnetic energy is detected; and

storing an indication that the hot-pluggable component is present when the absence of electromagnetic energy is detected.

15. The method, as recited in claim 12, further comprising the step of locating a material which is impervious to the electromagnetic energy at a position on the hot-pluggable component so that the material obstructs the electromagnetic energy when the hot-pluggable component is mated to the connector.

16. The method, as recited in claim 12, wherein the step of generating the electromagnetic energy comprises the step of generating a beam of electromagnetic energy directed toward the second opposing side of the system board.

17. The method, as recited in claim 12, wherein the step of generating the electromagnetic energy comprises the step of:

generating a plurality of independent beams of electromagnetic energy directed toward the second opposing side of the system board, a source of each of the plurality of beams located progressively more distant from the system board; and

further wherein the steps of detecting the presence or absence of the electromagnetic energy comprises the step of:

independently detecting the presence or absence of each of the plurality of beams on the second side of the system board, a detector of each of the plurality of beams located progressively more distant from the system board, the plurality of beams sequentially becoming obstructed as the hot-pluggable component is mated to the connector and the electromagnetic energy is obstructed by the hot-pluggable component and the beams sequentially becoming unobstructed as the hot-pluggable component is removed from the connector and the electromagnetic thereby becomes unobstructed by the hot-pluggable component indicating the approach or retreat of the hot-pluggable component respectively.

18. The method, as recited in claim 12, wherein the electromagnetic energy is infra-red energy.

ABSTRACT OF THE DISCLOSURE

A method and apparatus for detecting the presence of hot-pluggable components in a computer system. The method and apparatus includes an electromagnetic energy source located on a first side of a system board proximate an edge connector, the electromagnetic energy source for generating electromagnetic energy directed at least toward a second opposing side of the system board. The method and apparatus further includes an electromagnetic energy detector located on the second side of the system board, the electromagnetic energy detector for detecting a presence of electromagnetic energy when a hot-pluggable component is not mated to the edge connector and the electromagnetic energy is thereby unobstructed by the hot-pluggable component, the electromagnetic energy detector further for detecting an absence of electromagnetic energy when the hot-pluggable component is mated to the edge connector and the electromagnetic energy is thereby obstructed by the hot-pluggable component.

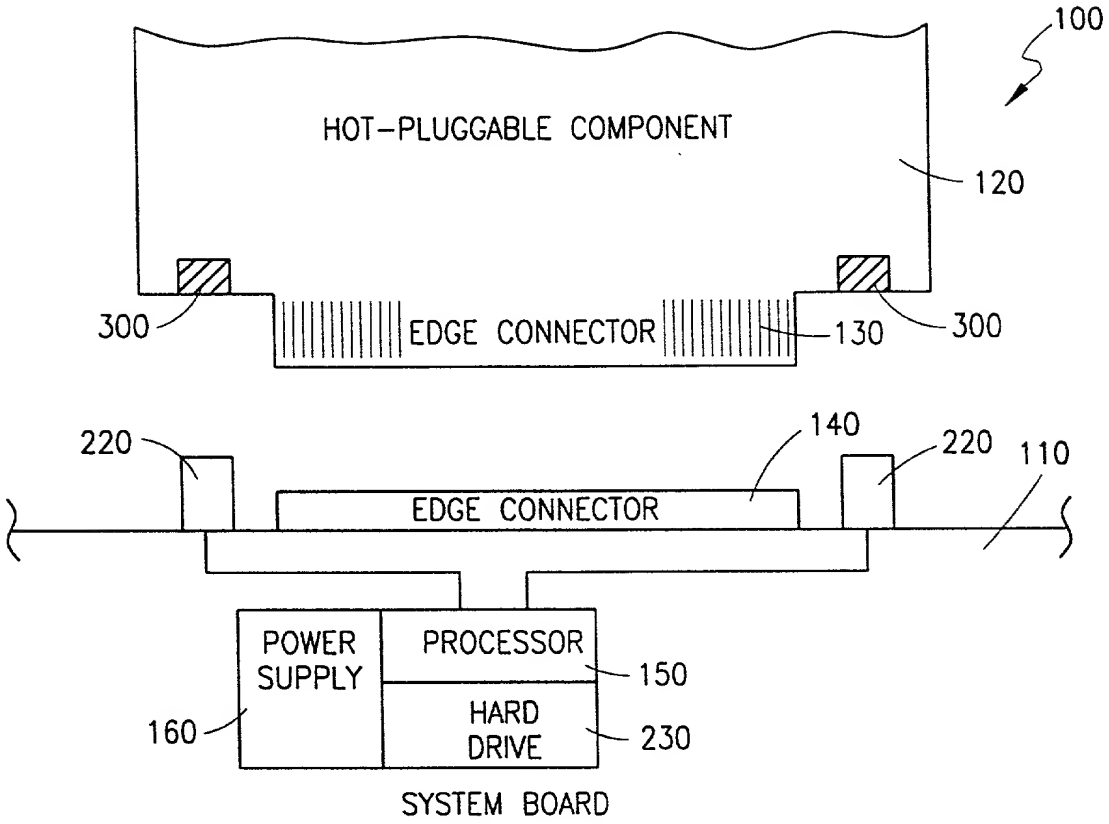
100
HOT-PLUGGABLE COMPONENT
120
300
EDGE CONNECTOR
130
300
220
140
220
110
EDGE CONNECTOR
POWER SUPPLY
PROCESSOR
150
160
HARD DRIVE
230
SYSTEM BOARD

FIG. 1

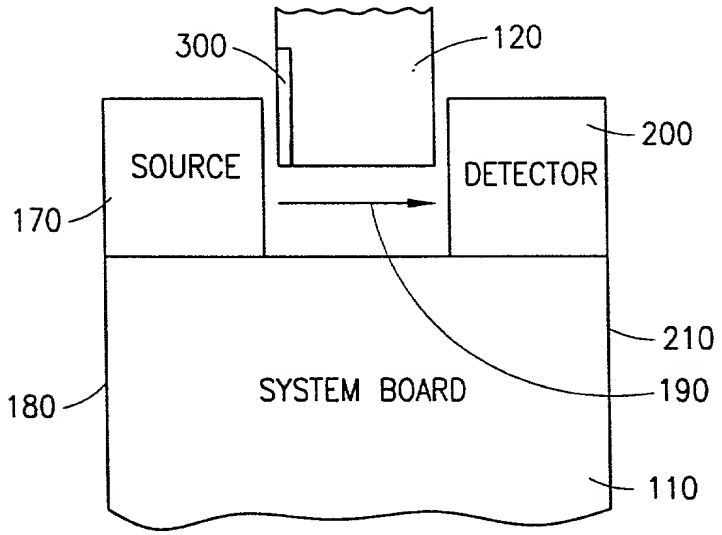
300
120
SOURCE
DETECTOR
200
170
210
SYSTEM BOARD
190
180
110

FIG. 2

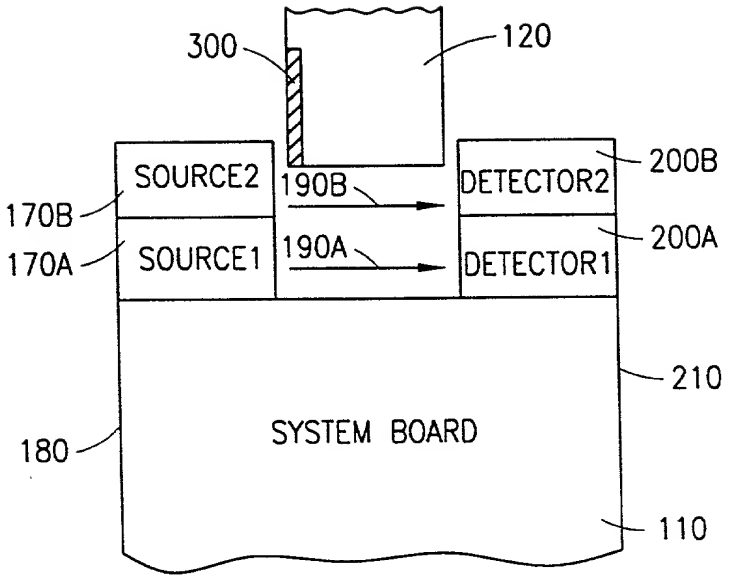
300
120
SOURCE2
190B
DETECTOR2
200B
170B
170A
SOURCE1
190A
DETECTOR1
200A
210
SYSTEM BOARD
180
110

FIG. 3

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DECLARATION

JOINT INVENTOR
ORIGINAL

As a below named inventor, I hereby declare that: my residence, post office address, and citizenship are as stated below next to my name. I believe I am the original, first, and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR DETECTING THE PRESENCE OF A HOT-PLUGGABLE COMPONENT IN A COMPUTER SYSTEM

as described in the specification [X] attached or [___] of patent Application Serial No. _____

filed _____ and amended on _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above; that I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application; that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representative or assigns more than twelve months prior to this application; and that I acknowledge the duty to disclose information of which I am aware which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations § 1.56(a). Such information is material when it is not cumulative to information already of record or being made of record in the application, and

(1) it establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or
(2) it refutes, or is inconsistent with, a position the applicant has taken or may take in:
  (i) opposing an argument of unpatentability relied on by the Office, or
  (ii) asserting an argument of patentability.

I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificates listed below and have also identified below any foreign application(s) having a filing date before that of the application(s) on which priority is claimed:

COUNTRY	APPLICATION NUMBER	DATE OF FILING	PRIORITY CLAIMED UNDER 35 USC 119
			☐ YES ☐ NO

I hereby claim the benefit under Title 35 United States Code § 120 of any United States application(s) listed below and, insofar as any subject matter of any claim of this application is not disclosed in the prior United States Application, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application and the national PCT international filing date of this application:

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Attorney Docket No. 27757-00414USPT
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant/Patentee: §
§
Patrick Raymond, Sompong P. Olarig §
§
Filed: Concurrently Herewith § *Atty File:* 27757/00414USPT
§ Compaq Docket No.: P98-2379
Serial No.: Concurrently Herewith §
§

For: METHOD AND APPARATUS FOR DETECTING THE PRESENCE OF A HOT-PLUGGABLE COMPONENT IN A COMPUTER SYSTEM

POWER OF ATTORNEY BY ASSIGNEE

Under the provisions of 37 C.F.R. § 3.71, the undersigned assignee of record of the entire interest in the above-identified patent/patent application by virtue of an assignment recorded (check as applicable):

☒ Concurrently Herewith
☐ Date Recorded _____
☐ Reel _____ Frame _____

elects to conduct the prosecution of the application/maintenance of the patent to the exclusion of the inventor(s). The undersigned hereby declares that she has reviewed the above-referenced assignment and hereby declares that, to the best of her knowledge, title is in the Assignee, and further declares that all statements made herein of her own knowledge are true and that all statements made on information and belief are believed to be true. The assignee hereby revokes any previous powers of attorney and appoints the following to prosecute this application/maintain this patent and transact all business in the Patent and Trademark Office connected therewith:

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ASSIGNEE
COMPAQ COMPUTER CORPORATION

Date: 7 Dec 1999

BY: Diane H. Strong
NAME: Diane H. Strong
TITLE: Administrator, Patents

Authorized To Sign This Document On Behalf Of
Compaq Computer Corporation
Pursuant To Board Of Directors Resolution
Date July 28, 1989